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IMPROVED PACKAGING FOR THE LN-31 INERTIAL MEASUREMENT UNIT (F-1--ETC(U)
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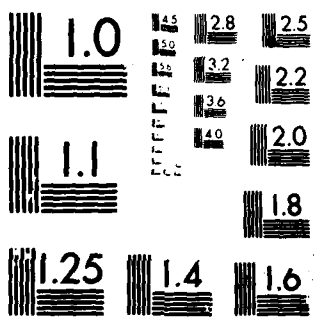


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PTPT Report No. 80-2
AFPEA Project No. 79-P7-30

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# IMPROVED PACKAGING FOR THE LN-31 INERTIAL MEASUREMENT UNIT (F-15 AIRCRAFT)



HQ AFALD/PTP
Air Force Packaging Evaluation Agency
Wright-Patterson AFB OH 45433

MARCH 1980

## NOTICE



## ABSTRACT

The investigation of the current packaging for the F-15 Inertial Measurement Unit (LN-31 IMU) revealed that the pack will provide adequate shock and vibration protection for the item; however, it was anticipated that a less expensive pack could be developed at a cost savings of approximately 25% (PTPT Report 79-3, Packaging and Handling Analysis of the LN-31, 683420-14, Inertial Measurement Unit). A new improved pack was developed and evaluated. The estimated cost savings is 20% and the potential implementation date is scheduled for June 1980.

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**PUBLICATION DATE:** 14 FEB 1980

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## INTRODUCTION

In cooperation with the Oklahoma Air Logistics Center (DSPC), the Air Force Packaging Evaluation Agency (AFPEA) designed and developed a new improved pack for the LN-31 IMU (F-15 aircraft). This pack can be used as an alternate method of packaging for this item.

## OBJECTIVE

The purpose of this study was to improve the pack as follows:

1. Provide a cushioning system which would eliminate the intricate design of the current cushioning system and replace it with a simplified design to reduce labor cost of fabricating this system.

2. Improve the mechanical latches to prevent accidental opening of the container.

3. Provide a moisture vapor seal, to replace the current water tight seal, for Method II environmental protection.

## DESCRIPTION OF TEST PACK

1. Container: The molded polyethylene container incorporates a vapor proof seal in the cover, seven 1/4 turn fasteners, a two-way pressure relief valve (option), four recessed handles, corner lid gussets (option) and a low temperature polyethylene container material which will withstand handling shock at $-40^{\circ}F$.

2. Cushioning System: Polyurethane (ester), two pounds per cubic foot, MIL-P-26514E, Type I, Class 2, Grade A.

The test pack and the current pack are compared as shown in Figure 1. Note the number of cut-outs and bevels in the cushioning system of the current pack as shown in Figure 1c. Details of the simplified cushioning system are in the sketch of Figure 2. Additional test pack information is presented in Table I.

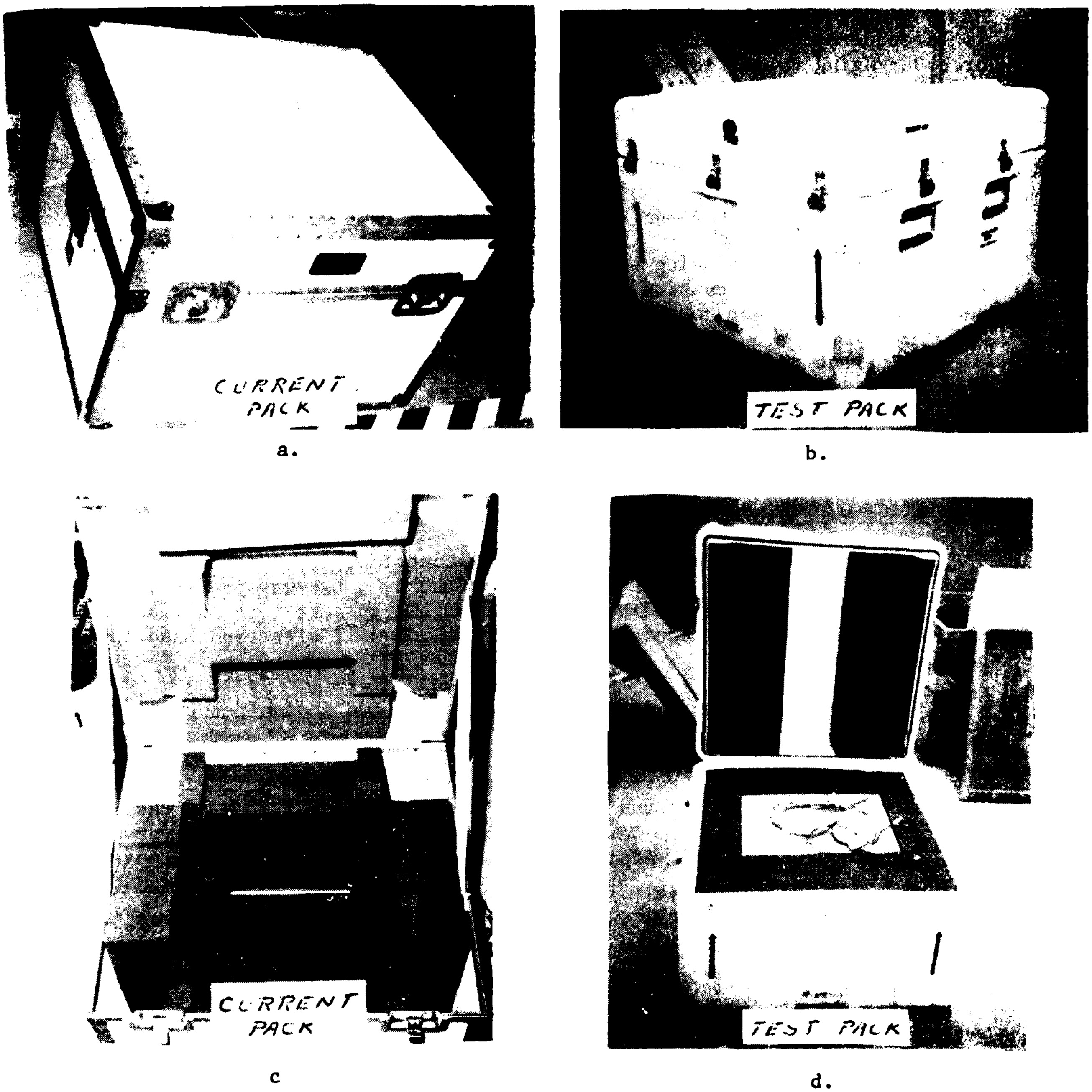


Figure 1. Comparison of Test Pack with Current Pack

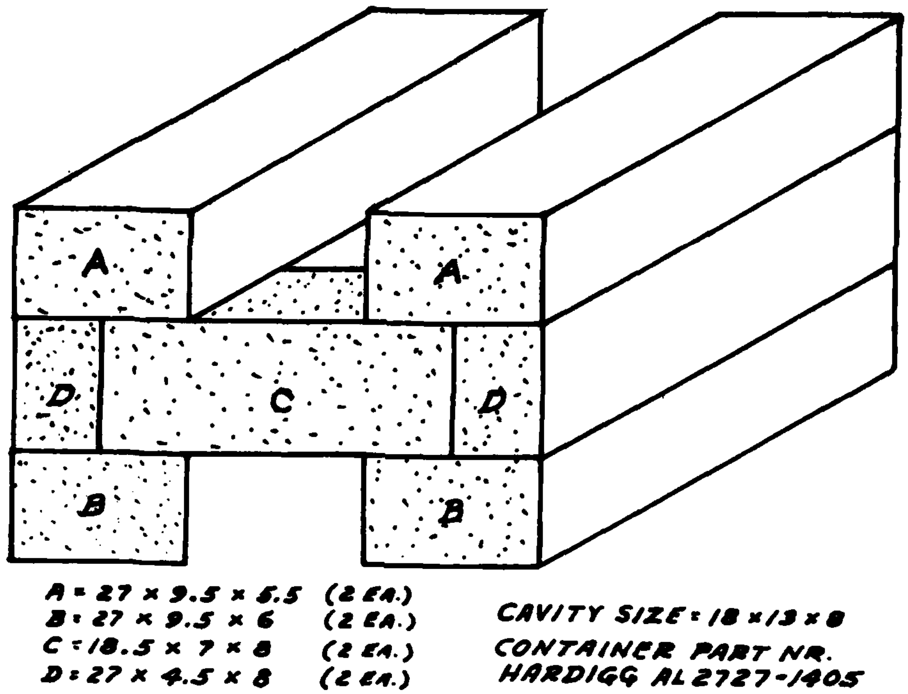


Figure 2. Sketch of Test Pack Cushioning System

| DIMENSIONS (IN.) | WEIGHTS - LBS. | | | CUBE ($FT^3$) | CUSHIONING MATERIAL | | LATCHES, QUANTITY | NUMBER HANDLES, QUANTITY |
|---|---|---|---|---|---|---|---|---|
| | ITEM | CONTAINER NET | CONTAINER GROSS | | TH'K (IN.) | DEN. (pcf) | | |
| 27x27x19 (Inside) 30x30x22 (Outside) | 37.5 | 52 | 89.5 | 11.5 | 4½-7 | 2* | 7 | 4 |

*Polyurethane (ester)

Table I. Test Pack Information

## Instrumentation and Equipment

The following instrumentation and equipment were employed for this evaluation:

1. Oscilloscope, Tektronic, 4 channel storage, Model 564B.

2. Accelerometer, tri-axial, Endevco, Model 2233E.

3. Amplifiers (3 ea.), Endevco, Model 2414C.

4. Power Supply, Endevco, Model 2622C.

5. Electrodynamic Vibrator, Unholtz-Dickie, Model 506.

6. Vibration Test Machine (mechanical), L.A.B. Corporation, Type 5000-96B.

7. Vibration Test Machine (mechanical), L.A.B. Corporation, Model 41012.

8. Transportation Environment Recorder, Bolt-Beranek and Newman Inc., Model 714, S/N 203.

9. Recorder Readout, Bolt-Beranek and Newman, Inc., Model 615.

10. Chain Hoist and Quick Release Mechanism.

## Test Procedure and Results

All of the tests were conducted in accordance with Federal Test Method Standard 101B, except as noted. A tri-axial accelerometer was located at the center of gravity of the wood simulated model of the LN-31 IMU as shown in the photograph of Figure 3.

Figure 3. Test Load

Repetitive Vibration Test - Method 5019: The test pack was vibrated for a period of two hours. The results are presented in Table II.

| Frequency (HZ) | Double Amplitude (Inches) | Response Acceleration (Test Load) Gs |
|---|---|---|
| 4.6 | 1 | 3.9 |

Table II. Repetitive Shock Vibration Data

Sinusoidal Vibration Test - Method 5020: The test pack was subjected to sinusoidal vibration, as shown in Table III for a total time of two hours.

| Frequency (HZ) | Duration (Minutes) | Double Amplitude (Inches) | Response Acceleration (Test Load) Gs |
|---|---|---|---|
| 2 | 5 | 1 | 0.6 |
| 3 | 5 | 1 | 0.9 |
| 5 | 5 | 1 | 3.0 |
| 5-500 | 45 | .036-.673 | 7.6 Max |

Table III. Sinusoidal Vibration Data

Free Fall Drop Test - Method 5007: The peak acceleration of the improved pack is compared to the peak acceleration of the current pack as listed in Table IV. The drop height was 21 inches.

| Impact Surface | PEAK ACCELERATION - Gs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | AFPEA Pack | | | | Duration (ms) | Current Pack | | | |
| | X | Y | Z | R | | X | Y | Z | R |
| 3 (Bottom) | 0 | 3 | 12 | 12.4 | 55 | 0 | 2 | 12 | 12.2 |
| 1 (Top) | 2 | 1 | 12 | 12.2 | 48 | 2 | 1 | 11 | 11.2 |
| 2 (Front) | 0 | 9 | 2 | 9.2 | 60 | 1 | 10 | 4 | 10.8 |
| 4 (Back) | 0 | 9 | 2 | 9.2 | 70 | 0 | 10 | 0 | 10.0 |
| 5 (L. Side) | 10 | 1 | 1 | 10.1 | 65 | 10 | 0 | 2 | 10.2 |
| 6 (R. Side) | 11 | 3 | 2 | 11.6 | 60 | 9 | 3 | 2 | 9.7 |
| | | | | Av.10.8 | | | | | Av.10.9 |

Table IV. Drop Test Data

Low Temperature Drop Test: Two containers, which were structurally identical but of a different chemical formulation of polyethylene, were subjected to low temperature (-20°F and -40°F) drop tests. The first container was a standard "off-the-shelf" ATA-300 (Air Transport Association Spec.) container which fractured during the -20°F drop tests. The second container was molded from a low temperature polyethylene formulation and survived the 21-inch drop at -40°F. Additional information concerning the material formulation is provided in the "Discussion" section of this report.

Superimposed - Load Test, Method 5016: This one hour test subjected the pack to a constant top to bottom compression load of 2176 pounds. The total deflection was 7/16 inches and no damage occurred to the container or the seal. The latches remained secure during the test.

Field Test: Two round trip shipments were made to Tinker AFB, OK, via Logair. A transportation environment recorder was secured in the cavity of the simulated LN-31 IMU as shown in Figure 4. The test results are listed in Table V.

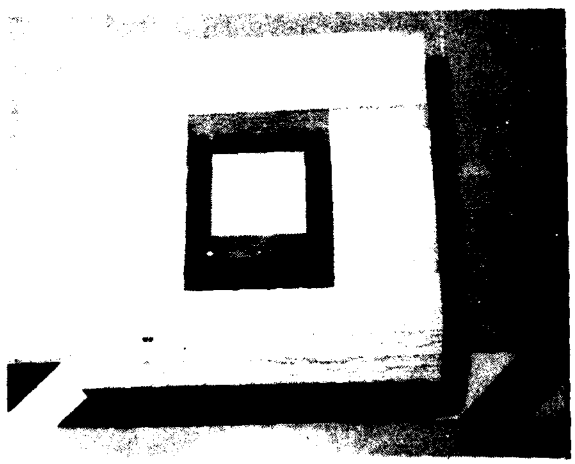

Figure 4. Test Load with Recorder

| Shock Level Range (Resultant Peak Acceleration - Gs) | Number of Recorded Shocks | |
|---|---|---|
| | Shipment #1 | Shipment #2 |
| 2.5 to 5.0 | 25 | 20 |
| 5.0 to 7.5 | 5 | 2 |
| 7.5 to 10.0 | 0 | 2 |
| 10.0 to 12.5 | 0 | 1 |

Table V. Field Test Data

Pressure Tests: The container was pressurized to 0.5 psi (27.5" $H_2O$) and the results are presented in Table VI.

| Test Phase | Pressure Drop Per Hour psi | Pressure Drop Per Hour inches of water |
|---|---|---|
| Before tests | 0.12 | 3.2 |
| After drop test (ambient) | 0.14 | 4.0 |
| After - 40°F drop test | 0.34 | 9.3 |
| After field & Comp. test | 0.38 | 10.5 |

Table VI. Pressure Test Data

Comparison of Test Pack with Current Pack: The advantages of the new improved pack are listed in Table VII.

| ITEM OF CONSIDERATION | CURRENT PACK | IMPROVED PACK |
|---|---|---|
| Latches | Latches opened during test | Latches secure |
| Seal | No seal | Vapor proof seal* |
| Pressure relief valve | No relief valve | Two-way 0.5 psi |
| Cushioning system | Intricate design | Simplified design |
| Cost, ea. (50 or more) | $250.00 | $208.00 |

*See "Discussion" section of report

Table VII. Advantages of Improved Pack

## DISCUSSION

During the early phase of this evaluation, the standard "off-the-shelf" container failed the low temperature requirement for the packaging of fragile avionics equipment. The container manufacturer was notified of the problem and he indicated that the low temperature polyethylene had, in the past, been available as an option at an increase in cost; however, effective November 1979, the standard "off-the-shelf" container molded from the low temperature polyethylene formulation became available at no increase in cost.

The cost study of the improved pack revealed a realistic cost savings of approximately 20%. Additional savings will also result because of improved latches and the addition of a water vapor gasket which could potentially eliminate the moisture vapor barrier material used with the item in the current pack.

The pressurization test of this container revealed that the seal is not adequate for Method II preservation during long term storage; however, if the item's packaging history revealed that short term storage is normal, the moisture vapor proof barrier material could be eliminated for an additional cost savings.

## CONCLUSIONS

The improved pack for the LN-31 IMU will provide the same or better environmental protection than the current pack at a cost savings of approximately 20%. The fragility rating of the LN-31 IMU is 15 Gs which is appreciably above the maximum shock level of 12.4 G recorded during the rough handling tests.

## RECOMMENDATION

Consider the purchasing of this container[1] as an alternate method of packaging for the LN-31 IMU.

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[1] Hardigg P/N AL2727-1405.

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PTPT Report No. 80-2

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
Improved Packaging for the LN-31 Inertial Measurement Unit (F-15 Aircraft)

5. TYPE OF REPORT & PERIOD COVERED

6. PERFORMING ORG. REPORT NUMBER
AFPEA Project No. 79-P7-30

7. AUTHOR(s)
10 Frank C. Jarvis 12) 13

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS
AFALD/PTPT
Wright-Patterson AFB OH 45433

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS
AFALD/PTP
Wright-Patterson AFB OH 45433

12. REPORT DATE
11) Mar [redacted] 80

13. ~~NUMBER OF PAGES~~

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)
14) PTPT-80-2

15. SECURITY CLASS. (of this report)
Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)
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DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
F-15 IMU (LN-31); packaging reusable container, shock and vibration test, field test

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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